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3,481,251

MACHINE WITH HYDRAULIC BOOM

Filed Feb. 5, 1968

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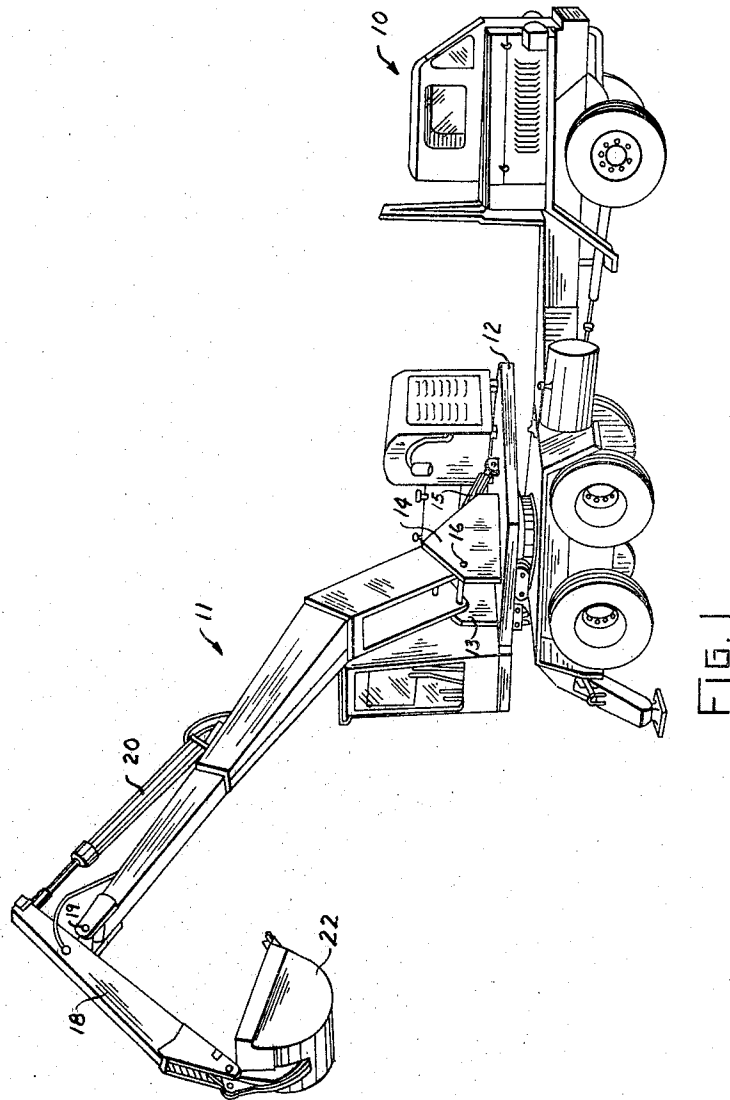


FIG. 1

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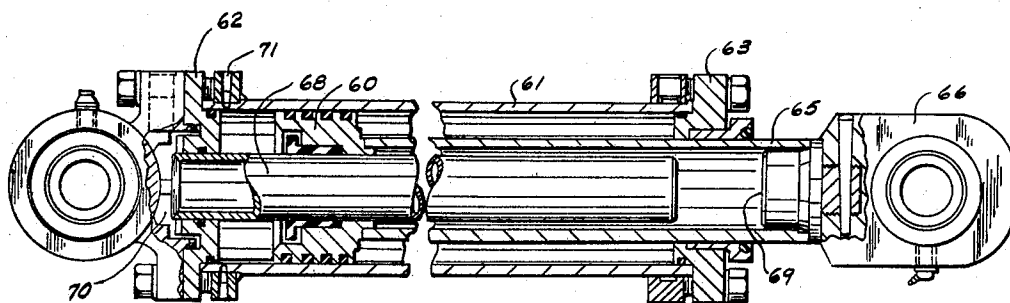
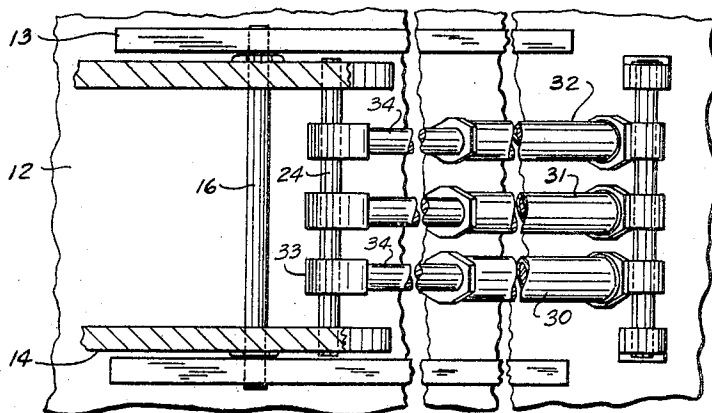
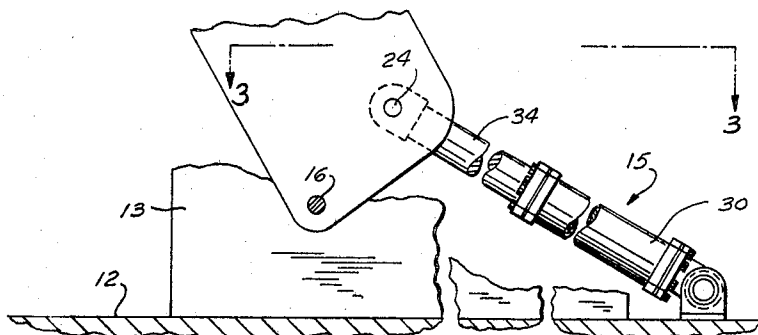
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3 Sheets-Sheet 2



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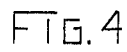
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3 Sheets-Sheet 3



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MACHINE WITH HYDRAULIC BOOM

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17 Claims

ABSTRACT OF THE DISCLOSURE

A backhoe having a plurality of hydraulic cylinders which are utilized to raise the boom in power or speed strokes selectively.

This invention relates to construction and material handling machines having a hydraulically operated boom and more particularly to such a machine having a boom which can be selectively operated through either a power stroke or a speed stroke.

Material handling and construction machines with hydraulically operated booms are sometimes used to transfer or handle relatively light loads but at other times are required to transfer and handle relatively heavy loads. These different requirements call for different speed and power characteristics if the load is to be handled in a most efficient manner. If the hydraulic system for the boom is designed for maximum power to handle heavy loads, its speed, when handling light loads, will be slow. If the hydraulic system for the boom is designed to handle light loads at a maximum speed, then problems arise when the boom is called upon to handle heavy loads.

Heretofore, there have been various proposals for changing the speed-power characteristics of a boom. These proposals have generally involved the changing of the mechanical connections between the boom and its supporting structure or actuating mechanism.

An important object of the present invention is to provide a new and improved machine having a hydraulically operated boom in which the operator can vary the piston area of the hydraulic actuating means to which fluid pressure is applied to move the boom to provide for power or speed in handling the load, as desired.

A further object of the present invention is to provide a hydraulically operated boom in which hydraulic power means for actuating the boom has a first piston area to which pressure is selectively applied when it is desired to operate the boom with speed and a larger piston area to which pressure is applied when power is required;

A further object of the present invention is to provide a new and improved excavating machine, such as a backhoe, in which a plurality of hydraulic piston-cylinder actuators are utilized to raise the boom when power is required and only part of the piston and cylinder actuators utilized to raise the boom when a light load is being handled.

While the present invention is susceptible of various modifications and constructions and of use in various machines employing fluid pressure means for operating a boom, it is particularly useful in construction machines and is herein shown as incorporated in a backhoe.

Further objects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment of the present invention in which:

FIG. 1 is a perspective view of a backhoe embodying the present invention;

FIG. 2 is an enlarged fragmentary view of a part of FIG. 1;

FIG. 3 is a view taken from approximately line 3-3 of FIG. 2;

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FIG. 4 is a hydraulic circuit diagram; and

FIG. 5 is an actuator which may be used in practicing the present invention.

Referring to FIG. 1, a truck mounted backhoe 10 is illustrated therein. The backhoe includes a boom 11 which is pivotally connected to spaced boom support plates 13, 14 for swinging movement about a horizontal axis 16 to raise the lower the boom and the boom is raised and lowered by the operation of hydraulic power means 15 connected between the boom 11 and the rotatable support platform 12.

The operator of the backhoe may swing the boom 11 horizontally by rotating the platform 12 with conventional power means.

The truck mounted backhoe 10 is a conventional type backhoe and in addition to the boom 11 has a dipper stick 18 pivoted to the free end of the boom 11 and adapted to be operated by a hydraulic piston-cylinder actuator 20. The dipper stick 18 is adapted to have a bucket 22 or other tool pivoted to its outer end and the bucket, or other tool, may be moved about its pivotal connection to the dipper stick by the operation of a hydraulic cylinder within the dipper stick 18.

As is shown in FIGS. 2 and 3, the power means 15 for raising and lowering the boom is connected to a shaft 24 extending between the side plates of the boom adjacent the boom support plates 13, 14. The shaft 24 is adjacent the top side of the boom and its relationship to the pivot for the boom 11 is such that the boom 11 may be raised by pulling downwardly on the shaft 24.

The power means 15 for raising the boom comprises, as is best illustrated in FIGS. 3 and 4, three hydraulic piston-cylinder actuators designated by the reference numerals 30, 31, 32. Each of the piston-cylinder actuators has a piston rod 34 connected to the shaft 24 by a connection 33 which allows the piston rods 34 to rotate about the shaft 24 as the boom is raised and lowered. The piston rods 34 are each connected to a corresponding piston 35 which operates within a cylinder 36 of the respective piston-cylinder actuators 30, 31, 32 have respective connections 30a, 31a, 32a for supplying fluid pressure to the rod end of the cylinders to move the piston rods inwardly of the actuators. When the piston rods 34 move inwardly of the actuators, they pull down on shaft 24 to raise the boom 11.

In the preferred and illustrated embodiment, the piston-cylinder actuators 30, 32 are single acting actuators and the head end of the actuators 30, 32 are always connected to drain while the head end of the piston-cylinder actuator 31 is connected to drain by a connection 31b through a three position control valve 38 which normally blocks the connection 31b, but which may be positioned to connect the head end of the actuator 31 to drain or to supply fluid pressure thereto through the connection.

When the boom is being used to handle relatively light loads where maximum power is not required, the boom is raised by supplying pressure fluid to the cylinder-actuators 30, 32 to move the rods 34 of these actuators inwardly to raise the boom. At the time that power is supplied to the actuators 30, 32, the head end of the actuator 31 is connected to drain so that this actuator has no effect on the operation of the boom. When the boom is to be lowered, the rod ends of the actuators 30, 31, 32 are connected to drain and the head end of actuator 31 is connected to the source of fluid pressure to cause the rods 34 to move outwardly of their respective cylinders 36.

If power operation is required, pressure is also supplied to the rod end of the piston-cylinder actuator 31 as well as to the rod ends of the actuators 30, 32. This increases the surface area of the power means 15 to which

fluid pressure is applied and, therefore, increases the power available. When the pressure is being supplied to the actuator 31 through the connection 31a, the head end of the actuator is connected to drain.

The connection of the rod end of the actuators 30, 32 and the connection of the head end of actuator 31 to pressure and drain respectively through cylinder conduit 31b are controlled by a valve 38. The connection of the rod end of actuator 31 to pressure and return respectively is controlled by a valve 40. The valve 38 has a normal or central position in which a pressure port 41 of the valve, which is connected to the discharge of a pump 42, is returned to drain and in which cylinder ports 41a, 41b are blocked. The valve 38 may be shifted to a position where the pressure port 41 is connected to the cylinder port 41a which, in turn, is connected via a conduit means 46 to the connections 30a, 32a to the rod ends of the actuators 30, 32 to supply pressure fluid to operate the actuators in a direction to raise the boom 11. When the valve 38 is in this position, the connection 31b to the head end of the piston-cylinder actuator 31 is connected to drain through a connection 49 which is connected to the cylinder port 41b. The rod end of the actuator 31 is normally connected to drain through the cylinder connection 31a and the valve 40.

If it is desired to effect power operation of the boom, this may be done by shifting the valve 38 to the position described for raising the boom and by shifting the valve 40 from its normal position to a position where a pressure port 50 for the valve 40 is connected through the valve to the connection 31a to the rod end of the piston-cylinder actuator 31. The pressure port 50 is connected to the cylinder port 41a of the valve 36 which is connected to the discharge of the pump 42 when the valve 38 is positioned to raise the boom. With pressure fluid now being supplied to the rod end of the actuator 31, maximum power is obtained.

When the boom is to be lowered, the valve 38 is shifted to a position where the pressure port 41 of the valve 38 is connected to the cylinder port 41b of the valve to supply fluid pressure to the connection 31b to the head end of the power cylinder 31. By supplying pressure to the head end of the power cylinder 31, the piston rod 34 will be moved outwardly in a direction to lower the boom. In this position of the valve 38, the cylinder port 41a of the valve 38 is connected to drain so that the rod ends of the piston-cylinder actuators 30, 32 will be connected to drain, as well as the rod end of the piston-cylinder actuator 31. It will be noted that the rod end of the piston-cylinder actuator 31 will be connected to drain when the valve 38 is in this position regardless of the position of valve 40 since in one position the valve 40 connects the rod end directly to drain while in its other position, it connects the rod end of the piston-cylinder actuator 31 to the cylinder port 41a of the valve 38 which is now connected to drain. The valve 38 must be operated each time that the boom is to be lowered and provides positive control of the boom.

The valve 38 is illustrated as being a valve which is biased to its central position and is shifted from its central position to either of its other positions by a lever 55 which in the actual structure would be connected to a valve spool with the valve spool being spring returned to its central position whenever the lever is released. The valve is preferably of the type which allows the pressure and chamber ports to be progressively opened and closed so as to provide the operator with fine control of the boom. If desired, the valve could be shifted by solenoids.

Similarly, the valve 40 is moved from its normal position to a position in which pressure is to be supplied to the rod end of piston-cylinder actuator 31 by the operation of a lever 56. The valve may be held by detents in each position.

While the preferred embodiment of the present invention utilizes three cylinders, it will be understood cylin-

ders could be combined into one or more actuators of the type shown in FIG. 5. In the actuator of FIG. 5, an annular piston 60 operates in a cylinder 61 having cylinder heads 62, 63 at the opposite ends of the cylinder. The piston 60 has a piston rod 65 connected thereto which extends outwardly through the cylinder head 63 and which has a connection 66 on its outer end corresponding to the connection 33 of the first described embodiment.

The piston 60 and piston rod 65 are hollow and a tube 68 is co-axially disposed within the piston 60 and the piston rod 65. The tube extends through the cylinder head 62 to open into a chamber 70 at the outer side of the cylinder head 62.

The actuator has a connection 71 adjacent the cylinder head 62 which opens into the cylinder 61. When fluid pressure is supplied to the cylinder 61 through the connection 71, the annular piston 60 is moved to move the piston rod 65 outwardly of the cylinder 61. The opposite side of the piston 60 is connected to drain. The connections to pressure and drain may be reversed to cause the piston 60 to move inwardly by power.

The piston rod 65 may also be moved outwardly of the cylinder 61 by supplying pressure fluid to the chamber 70 which communicates with the interior of the piston rod 65 through the tube 68 upon which the piston 60 slides. The piston rod 65 is closed at its outer end to provide an additional piston area 69. When fluid pressure is supplied to the chamber 70, it is communicated through the tube 68 to the interior of the piston rod 65. It then acts on the piston area 69 to extend the piston rod. When the piston rod is to be retracted, the chamber 70 is connected to drain.

It will now be appreciated by those skilled in the art that the actuator of FIG. 5 can be used to provide a power operation or a speed operation. If only the actuator of FIG. 5 is being used to operate the boom, normal operation for the boom would be accomplished by supplying fluid pressure to one or the other of the sides of the piston 60. If the boom is to be raised, pressure would be supplied to the head end of the piston 60 and the actuator would be connected to raise the boom on extension. Where the weight of the boom is used to lower the boom, the rod side of the piston 60 could always be connected to return or drain so that the cylinder is essentially single acting and the lowering of the boom controlled by the amount of fluid allowed to escape from the head end of the cylinder.

If additional power is required, the power may be obtained by supplying fluid pressure to the chamber 70 which is communicated to the interior of the piston rod 65 to increase the effective piston area of the actuator which, in turn, increases the power thereof.

It can now be seen from the foregoing that the present invention provides a new and improved apparatus and method for controlling the speed power characteristics of a boom, such as a boom used in an excavating machine, in a simplified manner. While the preferred embodiment of the present invention has been described, it is hereby my intention to cover all modifications, constructions and arrangements which fall within the ability of those skilled in the art and within the scope and spirit of the present invention.

What is claimed is:

1. In a machine, a moveable load carrying member to be subjected to different loads, fluid pressure actuating means for pivoting said load carrying member, and control means for selectively controlling the operation of said fluid pressure actuating means, said fluid pressure actuating means including piston and cylinder means having a plurality of operating areas against which fluid may act, said control means including first and second valve means selectively operable between a plurality of operating conditions, said first valve means having a first operating condition blocking fluid flow toward and from

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first and second operating areas of said piston and cylinder means, said second valve means having a first operating condition communicating a third operating area of said piston and cylinder means with drain when said first valve means is in its first operating condition, said first valve means having a second operating condition communicating said first operating area with a source of fluid under pressure and said second operating area to drain when said second valve means is in its first operating condition to thereby activate said piston and cylinder means to move said member in a first direction with a first speed, said second valve means being actuatable to a second operating condition to communicate said third operating area with said source of fluid under pressure when said first valve means is in its second operating condition to thereby activate said piston and cylinder means to move said member in the first direction with a second speed which is slower than said first speed.

2. In a machine as set forth in claim 1 wherein said first valve means is operable to a third operating condition communicating said first operating area with drain and communicating said second operating area with said source of fluid under pressure, said second valve means being operable to its first operating condition to communicate said third operating area with drain independently of said first valve means, said cylinder and piston means being activated upon operation of said first valve means to its third operating condition to move said member in a second direction opposite from said first direction.

3. In a machine as set forth in claim 2 wherein said second valve means communicates said third operating area with drain through said first valve means when said second valve means is in its second operating condition and said third valve means is in its third operating condition.

4. In a machine as set forth in claim 1 wherein said third operating area communicates with said source of fluid under pressure through said first and second valve means when said first and second valve means are in their second operating conditions.

5. In a machine as set forth in claim 4 wherein said second valve means blocks flow of fluid toward said third operating area from said source of fluid under pressure when said second valve means is in its first operating condition and said first valve means is in its second operating condition.

6. In a machine as set forth in claim 1 wherein said third operating area communicates with drain independently of said first valve means when said first and second valve means are in their first operating conditions.

7. In a machine as set forth in claim 1 wherein said piston and cylinder means includes a cylinder and first and second piston elements operatively associated with said cylinder and mounted for sliding movement relative thereto, said first operating area being located on one side of said first piston element and said second operating area being located on the opposite side of said first piston element, said third operating area being located on one side of said second piston element, said first and second piston elements and said cylinder being relatively movable to effect movement of said member in the first direction.

8. A machine as set forth in claim 1 wherein said piston and cylinder means includes a plurality of cylinders and a plurality of pistons each of which is operatively associated with one cylinder of said plurality of cylinders, said first operating area being located on one side of at least one of said plurality of pistons, said second operating area being located on one side of at least another of said plurality of pistons, said third operating area being located on a side of said other piston which is opposite from said one side.

9. A machine as set forth in claim 8 further including means for communicating at least one of said pistons

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to drain independently of said first and second valve means.

10. A machine as set forth in claim 1 wherein said piston and cylinder means includes a plurality of pistons with at least a part of one of said operating areas being located on one side of at least one of said pistons and at least a part of another of said operating areas being located on an opposite side of said one piston.

11. In a machine, a movable load carrying member to be subjected to different loads, piston and cylinder means for effecting movement of said member, said piston and cylinder means including at least one cylinder operatively connected with said member and a piston assembly located at least partially within said cylinder and including a plurality of interconnected operating areas mounted for simultaneous movement relative to said one cylinder to thereby move said member, and control means for selectively controlling the speed of relative movement between said piston assembly and cylinder to thereby control the rate of movement of said member, said control means including first and second valve means selectively operable between a plurality of operating conditions, said first valve means having a first operating condition blocking fluid flow toward and from first and second operating areas located on opposite sides of said piston assembly to thereby retard relative movement between said piston assembly and cylinder and to retain said member in a selected operated condition, said second valve means having a first operating condition communicating a third operating area of said piston assembly with drain, said first valve means having a second operating condition communicating said first operating area with a source of fluid under pressure and said second operating area to drain when said second valve means is in its first operating condition to thereby provide for relative movement between said piston assembly and cylinder to move said member in a first direction with a first speed, said second valve means being manually actuatable to a second operating condition independently of the fluid pressure communicated to said first operating area to communicate said third operating area with said source of fluid under pressure when said first valve means is in its second operating condition to thereby provide for relative movement between said piston assembly and cylinder to move said member in the first direction with a second speed which is slower than the first speed.

12. In a machine as set forth in claim 11 wherein said first valve means is operable to a third operating condition communicating said first operating area with drain and communicating said second operating area with said source of fluid under pressure, said second valve means being operable to communicate said third operating area with drain through said first valve means when said second valve means is in its second operating condition and said first valve means is in its third operating condition, said second valve means being operable when in its first operating condition to communicate said third operating area with drain independently of said first valve means, said cylinder and piston assembly being movable relative to each other upon operation of said first valve means to its third operating condition to move said member in a second direction opposite from said first direction.

13. In a machine as set forth in claim 11 wherein said piston assembly includes a piston element slidably mounted in said cylinder and a piston rod which is connected at one end portion to said piston element and is operatively connected at an opposite end portion with said member, said first operating area being located on one side of said piston element, said second operating area being located on an opposite side of said piston element, said third operating area being connected in fluid communication with a surface of said piston rod.

14. In a machine, a movable load carrying member to be subject to different loads, piston and cylinder means for effecting movement of said member, said piston and

cylinder means including a plurality of cylinder operatively associated with said member and a plurality of pistons each of which is associated with one of said cylinders, said pistons and cylinders being movable relative to each other to move said member, and control means for selectively controlling the speed of relative movement between said pistons and cylinders to thereby control the rate of movement of said member, said control means including first and second valve means selectively operable between a plurality of operating conditions, said first valve means having a first operating condition blocking fluid flow toward and from a first area located on one operating side of at least one of said plurality of pistons and a second area located on an opposite operating side of at least one of said plurality of pistons to thereby retard relative movement between said pistons and cylinders to maintain said member in a selected operated condition, said second valve means when in a first operating condition communicating a third area located on said one operating side of at least one of said plurality of pistons with drain when said first valve means is in its first operating condition, said first valve means having a second operating condition communicating said first area with a source of fluid under pressure and said second area with drain when said second valve means is in its first operating condition to thereby provide for relative movement between said pistons and cylinders to move said member in a first direction at a first speed, said second valve means being selectively actuatable to a second operating condition to communicate said third area with said source of fluid under pressure when said first valve means is in its second operating condition to thereby provide for relative movement between said pistons and cylinders to move said member in the first direction at a second speed which is slower than the first speed.

15. In a machine as set forth in claim 14 wherein said first valve means is operable to a third operating condition communicating said first area with drain and communicating said second area with said source of fluid under pressure, said second valve means being operable to communicate said third area with drain through said first valve means when said second valve means is in its second operating condition and said first valve means is in its third operating condition, said second valve means being operable when in its first operating condition to communicate said third area with drain independently of said first valve means, said cylinders and pistons being movable relative to each other upon operation of said first valve means to its third operating condition to move said member in a second direction opposite from said first direction.

16. In a machine, a boom to be subjected to different loads, fluid pressure actuating means having piston areas of different magnitudes for operating said boom and control means for selectively applying fluid pressure to

said piston areas of different magnitudes to selectively control the speed-power characteristics of said boom, said fluid pressure actuating means including a plurality of piston-cylinder actuators connected to said boom to swing said boom vertically, and said control means including means for supplying fluid pressure to first sides of said plurality of said actuators and to part of said plurality of actuators selectively to operate said boom in one direction and for supplying fluid pressure to said first sides of said part of said plurality of actuators and to a second control valve, said second control valve being operable to connect fluid pressure from said first valve to first side of the other of said plurality of piston-cylinder actuators to operate said boom in said one direction, said second control valve normally connecting said first side of said other of said actuators to drain and said first control valve operates to connect said first side of said other of said actuators to drain when supplying fluid pressure to said part of said plurality of actuators.

17. In a machine, a boom to be subjected to different loads, fluid pressure actuating means having piston area of different magnitudes for operating said boom, and control means for selectively applying fluid pressure to said piston areas of different magnitudes to selectively control the speed-power characteristics of said boom, said fluid pressure actuating means including a plurality of piston-cylinder actuators connected to said boom to swing said boom vertically, and said control means including means for supplying fluid pressure to first sides of said plurality of said actuators and to part of said plurality of actuators selectively to operate said boom in one direction, means for supplying fluid pressure to the side of said other of said plurality of actuators opposite to said first side to operate said boom in a direction opposite to said one direction, and a first valve having a first position for supplying fluid pressure to said first side of said part of said actuators and connecting said opposite side of said other of said plurality of actuators to drain and a second position for supplying fluid pressure to said opposite side of the other of said plurality of actuators and for connecting said first side of said part of said actuators to drain.

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